Effect of Storage Time on Quality Parameters of Flours from Fruit and Vegetable Pomace

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Introduction

The storage period is a critical factor influencing the quality of flours derived from fruit and vegetable residues, as it affects their physicochemical properties. Glass transition temperature (Tg), water activity (aw), and color parameters (L, a, b, c, and h) serve as indicators of flour quality, impacting their functionality and shelf stability. Understanding these parameters helps optimize storage conditions and extend flour quality over time.

Methodology

This study evaluated the effect of storage time on the physicochemical characteristics of flours produced from fruit and vegetable residues. Tg, aw, and color parameters (L, a, b, c, and h) were measured at three storage intervals: at the beginning (0 months), after 3 months, and after 6 months. Eight types of flours were analyzed: three apple flours (AP1, AP2, and AP3), beetroot flour (BT), celery flour (CL), and three flours from mixed fruit and vegetable residues (MIX1, MIX2, and MIX3).

Results

The average Tg values ranged from 47.9 to 53.1 °C, with MIX2 exhibiting the highest Tg and MIX1, MIX3, BT, and AP1 the lowest. The aw values ranged from 0.266 to 0.416, with CL showing the highest value and BT and AP2 the lowest.

Repeated measures ANOVA analyzed the impact of storage time (within-subject factor: Time; three levels: 0, 3, and 6 months; degree of freedom = 2) and flour type (between-subjects factor: Flour type; eight levels: AP1, AP2, AP3, BT, CL, MIX1, MIX2, and MIX3; degree of freedom = 7), including their interaction (Flour × Time; degree of freedom = 14). Both factors and their interaction significantly influenced all tested parameters ($p < 0.05$), except for the b parameter of color, where time had no significant effect ($p > 0.05$). Tg, aw, a, and c parameters increased over time, while L and h parameters decreased. In order to determine similarities among samples based on the analyzed parameters, Principal Component Analysis (PCA) was conducted. PCA grouped the samples into three clusters: Group 1 (AP1, AP2, and AP3), Group 2 (CL, MIX1, and MIX3), and Group 3 (BT and MIX2).

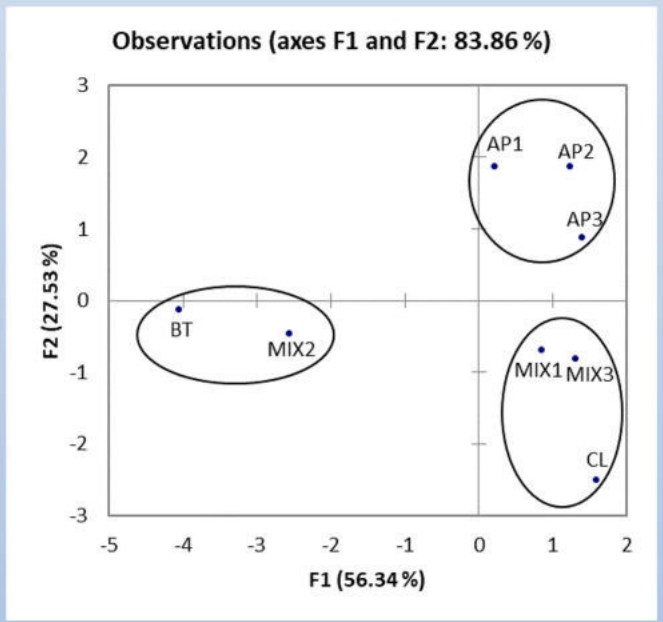

Fig 1. Distribution of samples in the PC1 × PC2 plane based on PCA of the physicochemical characteristics (Tg, aw, and color parameters)

Table 1. Effect of storage time on the physicochemical characteristics (Tg, aw, and color parameters)

	Tg (°C)	aw	L	a	b	c	h
0 month							
CL	43.3 ± 0.6	0.44 ± 0.01	55.8 ± 0.6	0.5 ± 0.2	20.6 ± 0.6	20.6 ± 0.6	88.5 ± 0.6
BT	47.2 ± 0.6	0.19 ± 0.00	34.0 ± 0.9	20.4 ± 0.0	8.5 ± 0.0	22.1 ± 0.0	22.7 ± 0.2
MIX1	44.7 ± 0.5	0.29 ± 0.01	60.0 ± 0.3	1.2 ± 0.4	21.9 ± 0.6	22.0 ± 0.6	87.0 ± 0.8
MIX2	47.2 ± 0.8	0.29 ± 0.00	51.4 ± 0.1	-0.4 ± 0.2	22.3 ± 0.4	22.3 ± 0.4	91.0 ± 0.6
MIX3	51.5 ± 1.4	0.35 ± 0.00	46.3 ± 0.1	16.0 ± 0.1	13.4 ± 0.2	20.9 ± 0.2	39.9 ± 0.1
AP1	47.0 ± 1.0	0.23 ± 0.00	64.8 ± 0.2	7.2 ± 0.1	27.2 ± 0.3	28.2 ± 0.3	75.2 ± 0.1
AP2	46.2 ± 1.5	0.34 ± 0.00	61.0 ± 1.0	7.3 ± 0.1	26.9 ± 0.3	27.9 ± 0.3	74.9 ± 0.3
AP3	50.1 ± 0.8	0.25 ± 0.00	60.2 ± 2.3	9.9 ± 0.4	25.3 ± 0.9	27.1 ± 1.0	68.6 ± 0.8
3 months							
CL	52.7 ± 0.7	0.41 ± 0.00	54.8 ± 1.0	1.2 ± 0.1	20.8 ± 0.7	20.9 ± 0.7	86.8 ± 0.2
BT	45.3 ± 1.3	0.30 ± 0.00	33.4 ± 1.5	20.2 ± 0.5	8.8 ± 0.0	22.1 ± 0.4	23.7 ± 0.5
MIX1	44.1 ± 1.2	0.32 ± 0.00	57.3 ± 0.4	1.5 ± 0.1	23.3 ± 0.4	23.3 ± 0.3	86.3 ± 0.3
MIX2	47.3 ± 0.8	0.34 ± 0.00	50.9 ± 0.1	-0.4 ± 0.1	23.0 ± 0.1	23.0 ± 0.1	91.1 ± 0.3
MIX3	52.7 ± 1.4	0.37 ± 0.00	45.6 ± 0.0	17.7 ± 0.3	13.8 ± 0.1	22.4 ± 0.3	37.9 ± 0.4
AP1	47.4 ± 0.6	0.28 ± 0.00	59.4 ± 0.9	7.3 ± 0.2	24.9 ± 0.5	25.9 ± 0.5	73.7 ± 0.4
AP2	50.6 ± 1.4	0.35 ± 0.00	59.4 ± 0.9	10.8 ± 0.1	26.3 ± 0.7	28.4 ± 0.6	67.6 ± 0.8
AP3	49.3 ± 1.2	0.31 ± 0.00	59.5 ± 1.9	10.8 ± 0.1	26.3 ± 0.7	28.4 ± 0.6	67.6 ± 0.8
6 months							
CL	55.1 ± 0.9	0.40 ± 0.00	54.1 ± 0.2	0.9 ± 0.1	20.2 ± 0.3	20.2 ± 0.3	88.0 ± 0.4
BT	51.8 ± 1.3	0.31 ± 0.00	33.2 ± 0.5	19.8 ± 0.6	8.3 ± 0.2	21.4 ± 0.7	22.3 ± 0.4
MIX1	55.6 ± 1.2	0.33 ± 0.00	59.0 ± 0.5	1.4 ± 0.1	23.7 ± 0.3	23.7 ± 0.4	87.0 ± 0.6
MIX2	49.2 ± 0.6	0.34 ± 0.00	50.2 ± 0.4	-0.3 ± 0.1	21.7 ± 0.4	21.7 ± 0.4	90.3 ± 0.3
MIX3	55.3 ± 1.2	0.38 ± 0.00	46.5 ± 0.2	17.1 ± 0.4	13.4 ± 0.1	22.0 ± 0.3	36.9 ± 0.7
AP1	55.9 ± 0.7	0.30 ± 0.00	66.8 ± 0.5	6.9 ± 0.2	26.6 ± 0.1	27.4 ± 0.1	75.7 ± 0.1
AP2	47.9 ± 0.8	0.35 ± 0.00	60.6 ± 0.8	7.1 ± 0.3	25.5 ± 0.4	26.5 ± 0.4	74.3 ± 0.3
AP3	55.4 ± 1.4	0.36 ± 0.02	57.9 ± 0.3	11.3 ± 0.1	26.8 ± 0.3	29.1 ± 0.3	67.2 ± 0.2

Conclusion

Findings in this study indicate that storage time significantly impacts the glass transition temperature, water activity, and color of flours produced from fruit and vegetable residues, thereby affecting their overall quality. Special attention should be given to packaging and storage conditions to preserve the quality of these flours over time

Acknowledgement

This research was supported by the Science Fund of the Republic of Serbia, 7439 GRANT No, From Waste to Food and Soil Enrichment - minimizing waste by applying circular economy in fruits/vegetables processing industry-WasteBridge and by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, grant numbers: 451-03-136/2025-03/200051. Authors express gratitude for apple and beetroot pomace materials to domestic juice producers Fruvita doo Smederevo and ColdPressok, Beograd.

Science Fund of the Republic of Serbia

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